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A SIMULATED ANNEALING AND NEAREST NEIGHBORHOOD APPROACH TO SOLVE A VEHICLE ROUTING PROBLEM IN A FMCG COMPANY

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ABSTRACT

Recently, there are certain category of supply chains which are fast emerging such as online groceries, fast moving goods which are low in cost and fast moving. The logistics cost of these supply chains is very important and they need to be delivered in the shortest possible time. All these problems are categorized into a vehicle routing problem. In certain problem, additional constraints such as time slots are also introduced so as to deliver the goods in particular time. Thus, it becomes very important to make the vehicle scheduling efficient. It becomes Non Polynomial when there is more than one vehicle in the delivery system. A vehicle routing problem is defined as a system of a vehicle covering a geographically dispersed routes which are covered in the shortest possible time. The vehicle should not visit any of the routes twice. In this paper, we have used simulated annealing and nearest neighborhood algorithms to compare and solve a designated set of routes in which a FMCG company delivers the goods to its customer.

KEYWORDS: Categorized into a Vehicle Routing Problem & Geographically Dispersed Routes

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Original Article

INTRODUCTION

In all optimization problems, there is a limit to the number of routes it can solve as the number of objects becomes large the combinatorial method of optimization is unmanageable. The combinatorial optimization is NP hard, the traveling salesman problem and vehicle routing problems fall under this category. A practical way to solve these problems is thru Simulated annealing and Nearest neighborhood algorithms. These algorithms do not yield the optimum solution, but they yield near optimal solution in the presence of a noisy data. All vehicle routing problems and traveling salesman problems can be best solved by Simulated annealing techniques. Minimizing the distance between the various cities or routes is the main goal of TSP. A randomized tour can be started by the salesman from any city and the tour can be completed in the shortest possible time by exchange of cities. In these problems, SA easily reaches the local optimum point, but it does not reach the global optimum point.

The Simulated annealing algorithm improves its strategy by adopting two tricks. There are certain bad trades which do not reduce the distance between the cities is accepted due to Metropolis algorithm (Metropolis et al. 1953).

The second trick mimics the annealing process in a metal in which the temperature is lowered gradually.

The bad trades can be minimized by lowering the temperature and after making many tour exchanges. There will be acceptance of good trades as the temperature is frequently lowered, which is similar to quenching in annealing. The acceptance of good trades result into local minima.

It is easy to implement the nearest neighbor algorithm and is executed quickly, it yields quick results. There is a disadvantage in implementing NN algorithm as it misses shorter routes due to its greedy nature and can be easily detectable by the human sight. The tour is reasonable, if the latter stages of the tour are comparable in length to the first few stages. We can use the lower bound algorithm to check the results of NN are good enough or not.

LITERATURE REVIEW

Dantzig and Ramser [1] were the first to introduce the Vehicle Routing Problem (VRP). The non polynomial problems are hard to solve and VRP is one of them; There are many improvements which have been done over the years on this vehicle routing problems. An improved version of the vehicle routing problem is Capacitated Vehicle Routing Problem (CVRP). It involves the design of optimal delivery routes reaching out to different customers located at different locations, the constraint being the vehicle capacity [2]

There is a lot of research going on in the field of Hybrid Meta Heuristics but they are very complex to solve. Constructive heuristics are less in complexity, and they have less computational time with medium accuracy. They are very useful in meeting the delivery requirements of FMCG company[3]. For problems with large customer depots or routes, some exact algorithms have been proposed, but they are not adequate to solve [4]. Famous constructive heuristics are Clarke and Wright Savings algorithm [5], Sweep Algorithm [6] and the Cluster First and Route Second Fisher and Jaikumar [7] algorithm, Holmes and Parker algorithm [8] and a popular local improvement heuristic is K-Opt Exchange method [9]. Many other algorithms have been used in the past to solve such kind of problems [10-19]. Simulations have helped the researchers to avoid many costly experiments [20,21]

Algorithm Based On SA

Step1: The starting point is defined by $\mu(0)$, α is set as the termination criterion. A high value is assigned to T,n is the number of iterations to be performed at a particular temperature, and set t=0.

Step2: $\mu(t+1) = N(\mu(t))$ is defined as the neighboring point. in the neighborhood is created usually, a random point

Step3: $\Delta\tau = (\Delta\tau(\wedge((t + 1)) - \tau(\wedge((t))) < 0, = + 1$; Else create a random number (r) in the range(0,1). If Else go to step2.

Step4: If $|\wedge((t + 1)) - \wedge((t))| <$ and as T becomes small, Terminate the solution; Else if (t mod n)=0 then reduce T according to a cooling schedule go to step 2;

Algorithm Based On NN

These are the steps of the algorithm:

- The tour can started randomly from any city and it can be choosen as an arbitrary vertex which can be set as current vertex.

- Determine the shortest edge connecting the nearest vertex which is unvisited and current vertex
- We can set current vertex as V.
- The city visited is denoted as V.
- The program can be terminated when all the vertices are visited.
- Go to step 2.
- All the visited cities which are the vertices is the output of the algorithm.

Implementation of Algorithm

The Vehicle routing data have been shown in Table 1. The data on TSP has been tested with SAalgorithm and NN Algorithm on MATLAB Version 2016. This data on FMSCG has been collected on one of the famous supply chains in Bangalore. A snap view of the various depots visited by the vehicle in terms of latitude and longitude has been recorded.

Table 1: **Distances in Latitude and Longitude for the Various Customers and Depot**

Customer No.	X-Co-Ordinate	Y-Co-Ordinate
Depot	**40**	**50**
1	45	68
2	45	70
3	42	66
4	42	68
5	42	65
6	40	69
7	40	66
8	38	68
9	38	70
10	35	66

RESULTS

The Nearest Neighbor Algorithm performs better than Simulated Annealing Algorithm. The results of NN Algorithm select the best route covering a distance of 261 units for a demand of 50 Customers is optimally selected for the best route. The SA performs well at 100 degree compared, but it covers a distance of 300 units. The shortest route solved thru NN Algorithm has performed well in obtaining the desired results given in Figure 1-2.

Table 2: **The Results of SA and NN Algorithm**

No of Depots	Simulated Annealing	Nearest Neighbor
50	300 Units	261 Units

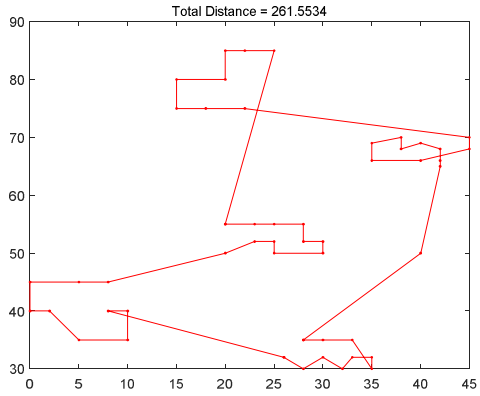

Figure 1: Results of TSP using NN Algorithm

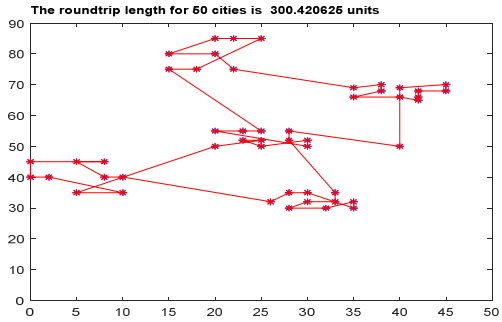

Figure 2: Results of TSP using SA Algorithm

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